GUIDE TO THE
THIRTY-FIFTH ANNUAL FIELD CONFERENCE
OF THE
SECTION OF GEOLOGY
OF THE
OHIO ACADEMY OF SCIENCE

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GEOLOGY OF THE YELLOW SPRINGS REGION

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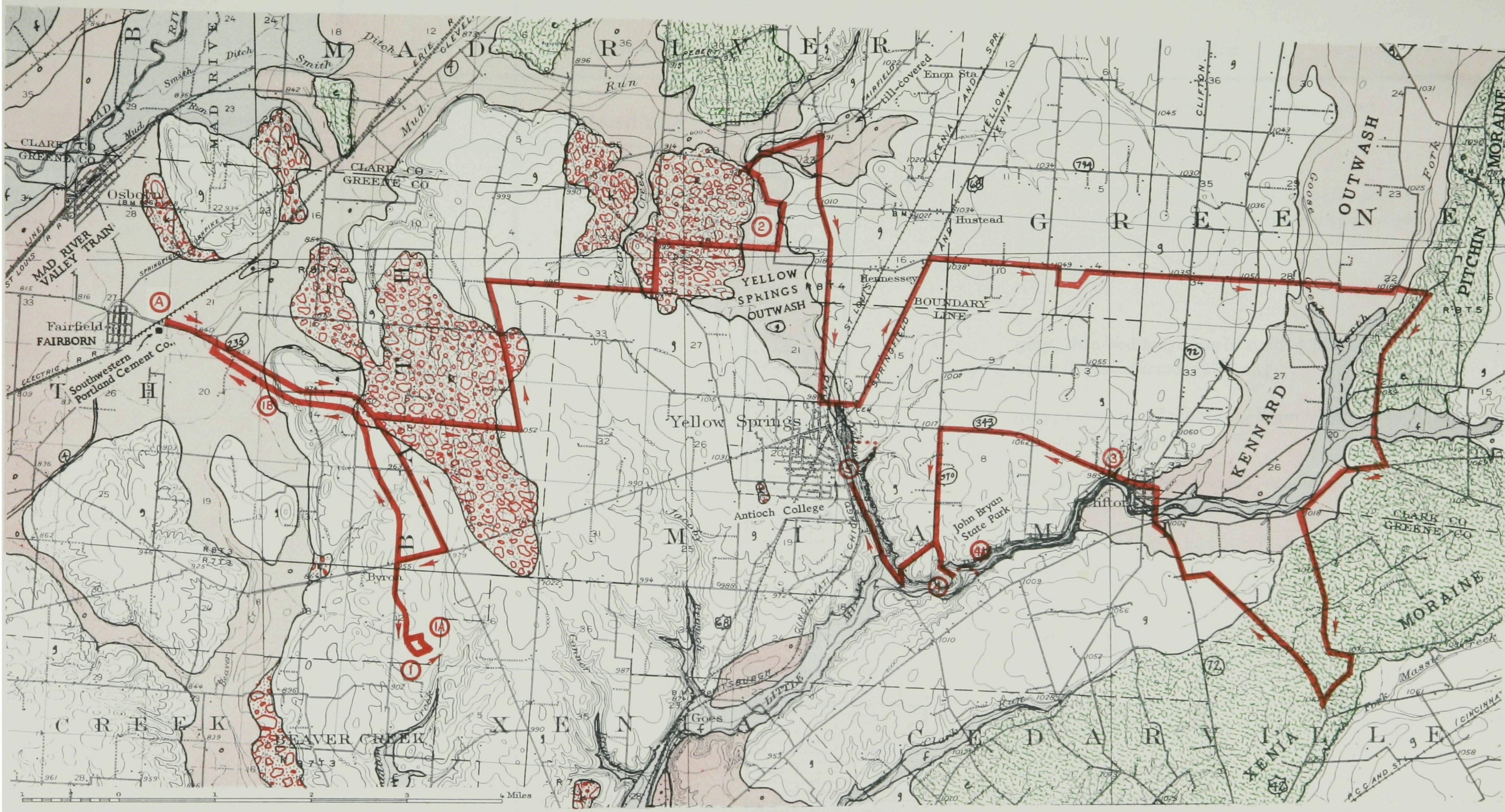


Field trip route

Field trip stops

Road route nos.

f floodplain

o outwash and valley train

kames

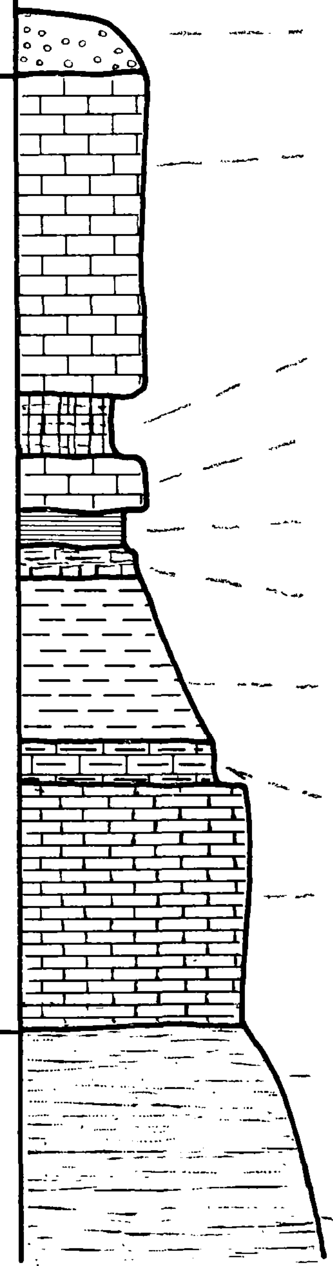
e end moraine

g ground moraine

THE GLACIAL DEPOSITS IN THE YELLOW SPRINGS AREA

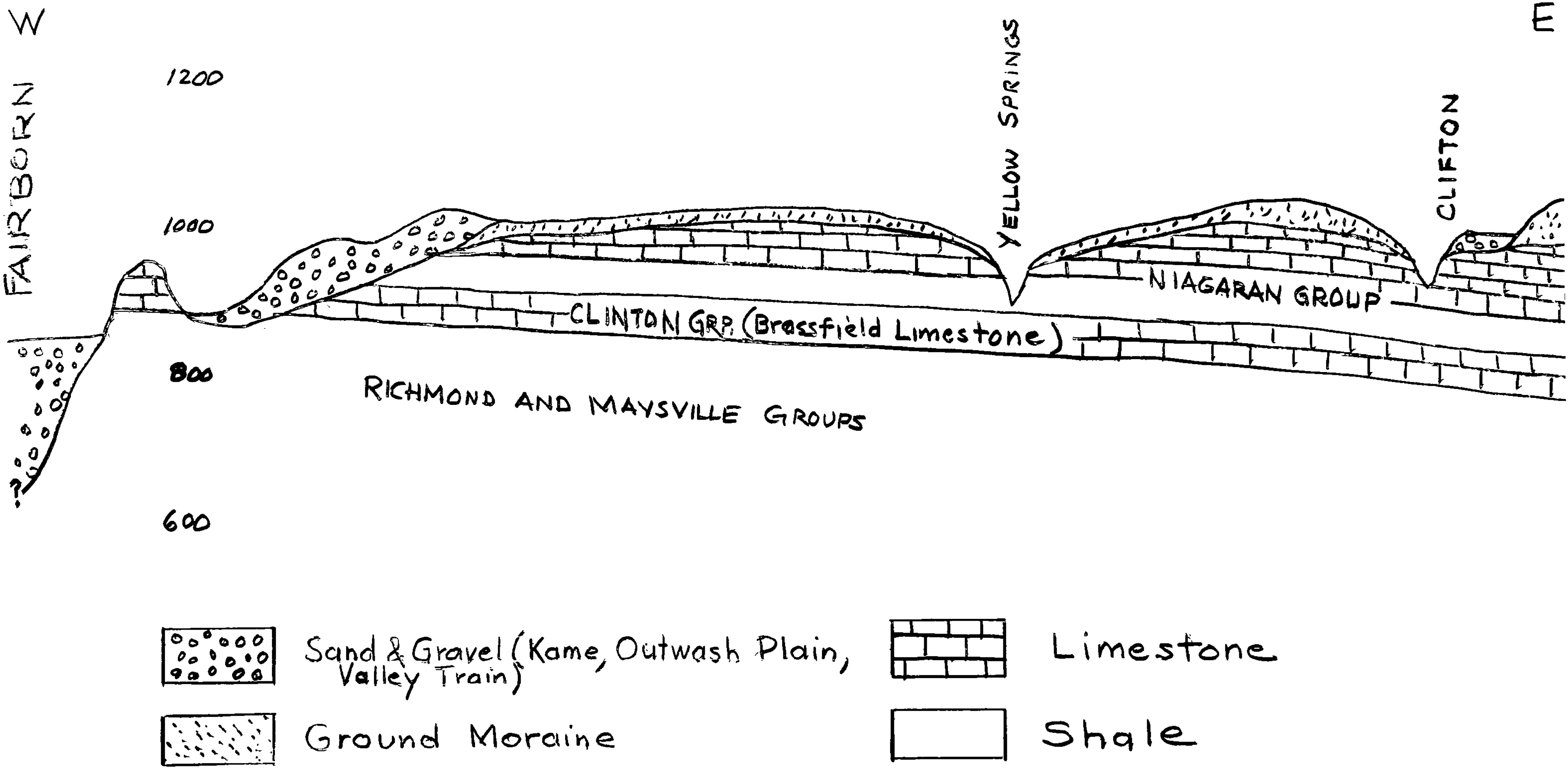
after R. P. Goldthwait 1950, 1952

STRATIGRAPHIC SECTION -- YELLOW SPRINGS REGION



System	Group	Formation	Description
Quaternary	Pleistocene series	Glacial Drift	ground and end moraine, outwash, kames, valley-train deposits, (0-400 feet)
Silurian	Niagaran	Cedarville Dolomite	gray, massive, in places medium beds, porous, pitted, cliff-former, regular widely spaced joints, (up to 50 feet)
		Springfield Do.	gray, thin bedded, closely spaced joints, brick-like structure. (10 feet)
		Euphemia Do.	gray, massive, in places medium beds, porous, (7-15 feet)
		Massie Shale	blue-gray, soft, thin bedded, calcareous, interbedded thin dolomite, (6 feet)
		Laurel Do.	buff, hard, medium bedded, fine dolomite, interbedded shale, (5-7 feet)
		Osgood Shale	blue-gray, weathers light brown, calcareous, interbedded thin to medium fine dolomite, fossils rare (25 feet)
	Clinton	Dayton Limestone	white, hard, medium and evenly bedded, dolomitic. (5-8 feet)
		Brassfield Limestone	white to pink, locally gray, brown, red; irregularly bedded; cliff-former; upper portions lens-like, thin beds, crinoidal; lower portion dolomitic, porous, sandy textured. (30-50 feet)
Ordovician	Richmond	Elkhorn Shale	yellow-brown siltstone, blue-gray, soft shale, red to variegated, soft shale, calcareous.
		Whitewater shale	blue-gray, calcareous shales, thin limestone beds.

DIAGRAMMATIC CROSS SECTION



GEOLOGY OF THE YELLOW SPRINGS REGION

Assembly - 8:00 A. M. in parking space at office and plant of Southwestern Portland Cement Co., Fairborn. The office is located on State Route 235 (Xenia Drive) on the south side of the road and about 0.7 miles easterly from the center of Fairborn. A large sign and the plant itself mark the location. Park in parking area for assembly.

Trip Guide

Assemble	8:00 Fairborn
Field Trip	8:00-12:30 Fairborn, Yellow Springs, Clifton
Lunch	12:30-1:30 Bryan State Park
Field Trip	1:30-5:00 Bryan State Park, Yellow Springs

Box lunches and coffee will be available at Bryan State Park. Sign up for lunches at registration desk.

For general geologic setting, see the diagrammatic cross section, stratigraphic section, and map. The map also gives the trip route.

Drivers - A large number of cars are expected. Please place your car in the parking areas, so that the largest possible number of cars can be accomodated. While en route, keep in line and drive slowly and carefully.

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TRIP LOG

Mileage Individual	Mileage Total	
0.0	0.0	Leave assembly area. Follow guide car.
		Turn right with caution onto Route 235 and proceed easterly.
		Surrounding flat plain is part of the extensive Mad River valley train up to 250 feet thick in the vicinity of Fairborn. The glacial material is underlain by Ordovician shales, of the Richmond group (Elkhorn, Whitewater, Liberty, Waynesville).
0.9	0.9	The erosional scarp trending across road is capped by resistant Brassfield limestone.
		Upper part of the Richmond group (Ordovician) and lower Brassfield limestone (Silurian) are exposed. Note contact, bedding, and general character of formations.
0.2	1.1	Worked-out quarry areas on left and right. Quarry faces are upper Brassfield.
0.3	1.4	Junction with New Germany-Trebein Road, continue straight ahead. Quarry and pond visible to right.
0.5	1.9	Junction with Byron Road; continue straight ahead.
0.2	2.1	Junction with Herr Road on left; continue straight ahead. Hills on left are kames. Road is on what has been called "thin ground moraine" because of the shallowness of the fill cover over the bed rock.
0.6	2.7	Pass under power line.
0.1	2.8	Junction with Folk Road; continue straight ahead.
1.0	3.8	Blinking yellow light. Turn right <u>with caution</u> from Ohio Route 235 onto Dayton-Yellow Springs Road.
0.5	4.3	Pass over quarry railroad.
		Turn left on company road 300 feet past railroad overpass.
0.4	4.7	Turn left at first driveway.
0.6	5.3	Glacially eroded surfaces showing striations oriented to the southeast, made by Miami lobe ice, are exposed on both sides of road.
0.3	5.6	Arrive at Quarry E of Southwestern Portland Cement Co.
		Follow lead car and park.
		<u>Stop 1.</u> <u>Quarry Floor.</u>

The quarry floor is at the base of the upper Brassfield formation. For general geologic setting refer to cross-section and stratigraphic section.

1. Brassfield Limestone. The Brassfield limestone is typically an irregularly bedded, coarsely crystalline, well-cemented, pink limestone which is in places made up chiefly of crinoid fragments. However, the character of the formation is highly irregular as can be seen in the quarry faces. The drill-hole log below describes a typical section.

Color locally ranges from hematite-red to green depending on the relative amounts of ferric and ferrous iron. The bedding is highly irregular in thickness and lateral continuity. Beds frequently lens out within a short distance. The lenses of blue clay are irregularly distributed.

2. The lower part of the Brassfield Formation. The lower Brassfield grades into the upper Brassfield but is physically and chemically distinct. It is a light brown friable, sandy textured, porous and permeable, dolomite limestone. The high porosity and permeability of the lower Brassfield, plus the fact that it is underlain by the impervious Elkhorn shale, make it an important aquifer and one of the chief sources of domestic water. The porosity and permeability are thought to be chiefly a result of solution.

3. The upper part of the Brassfield Formation. The upper part of the formation is a relatively pure, calcium limestone and is the only local source suitable for making Portland cement. The magnesium content is quite variable but is generally less than 5% compared to 15% for the lower Brassfield formation. The higher magnesium content of the lower formation is attributed to preferential leaching in the aquifer zone of the more soluble calcite, thus producing enrichment of dolomite in the lower beds.

DRILL LOG

Footage	Description
0-10'	Till 3 inches Dayton limestone
(upper Brassfield)	
10-11	Pink, highly fossiliferous, coarsely crystalline limestone; yellow clay seams common; material becomes dense, gray-green, silty lower 6"
11-13	Pink limestone highly pyritized, crystals to 1/2", highly fossiliferous, clay seams (green) common, badly shattered in lower half of section, gray tint
13-15	As above, upper 2' grades into firm fossiliferous pink crinoidal limestone
15-17	Pyritized (crystals to 3/8") material changing to gray-green tint; clay seams interbedded throughout lower 2/3 of core, highly fossiliferous (crinoid fragments predominate)

17-19		Upper 1' as above, lower is pink, coarse crystalline, crinoidal limestone, styolites common, firm, dense
19-21		Becoming porous in texture, silty in appearance, light brown in color, styolites common, very fine clay seams
21-27		Brown-green cast, silty in appearance, many fine clay seams, clay seams to 2" throughout, silty appearance, gray-green in color turning pink in lower portion
27-29		Pink-gray, crinoidal limestone; styolites common, occasional solution cavities near base
(lower Brassfield)		
29-31		Pink to brown material becoming porous, clay seams, rare oxidized solution passages, coarse crystalline fossilliferous material, shell fragments common
31-35		Porous crinoidal limestone, firmly compacted, intermediate cementation, brown to pink cast
35-37		As above, upper 1' appears sandy brown, oxidized color throughout upper two-thirds of section. At 36' dense well-cemented crystalline with styolites, common blue-green silty appearance, toward base green to black surface coatings at breaks. This is the base of the Brassfield formation.

4. Economic Geology. The Fairborn area produces about 1 percent of world production of portland cement. A bit of background, perhaps, will be in order at this time. To begin with, concrete in its simplest definition is a mass of aggregates (gravel, crushed stone, sand, etc.), held together by a hardened paste of Portland cement and water. The paste can be pictured as a continuous enveloping matrix which completely encases each aggregate particle and binds all particles into one mass. The aggregates are essentially inert; the cement paste is the active element.

When cement is mixed with water to form a paste, the cement reacts with the water to form new minerals which adhere to each other, and to the aggregate particles. The new minerals bind the whole together and give concrete its useful properties. In order to have a cement which will have the desired characteristics, the chemical composition must be held within established limits. One of these limits is the amount of allowable magnesia, which is set by federal and state specifications at a maximum of 5%. For this reason the lower Brassfield limestone cannot be used for manufacture of Portland cement because of its high magnesium content of 9 to 18 percent.

The company booklet explains the various ingredients needed to produce cement and it explains the process whereby this "stone" and other ingredients are converted to cement.

Return to cars. Other areas of the quarry may be visited depending on time and quarry conditions. Follow the leader.

0.1 5.7 stop 1-A. Stripped area to north and above Stop 1.

5. Glacial Erosion Surface. Approximately 20 acres has been stripped of overlying glacial material (chiefly till) as much as 80 feet thick. This surface represents an old erosion surface polished, abraded, and striated, by ice movement. Fossil forms and rock

textures show well on the polished surfaces. The direction of ice movement is toward the southeast, having been made by the advancing margin of the Miami lobe ice. Criss-crossing striations, representing ice advance from two different directions, ie. from both lobes, have been observed on these surfaces. A resume of the glacial setting will be made at this point.

From the point of view of glacial geology, the region covered by this field trip is one of the most interesting and challenging in Ohio. It lies within an "interlobate" area, between the major deposits of the Scioto (eastern) and Miami (western) glacial lobes, and is further complicated by the presence of the Silurian bedrock escarpment (held up mainly by the Brassfield limestone and Cedarville dolomite). This escarpment, which is shown on Fig. 1, was over a hundred feet high when the glaciers advanced into the region, so it greatly influenced the arrangement and nature of the deposits left by the ice. Instead of a respectable series of parallel end moraines, the marginal glacial deposits occur as small irregular areas of end moraine and kames in a scattered disorganized distribution that makes correlation of deposits extremely difficult. A strikingly high area may be end moraine, kame, or the escarpment itself thinly covered by drift; bedrock exposures or well records may help to identify it, in some places, but such data are not available everywhere.

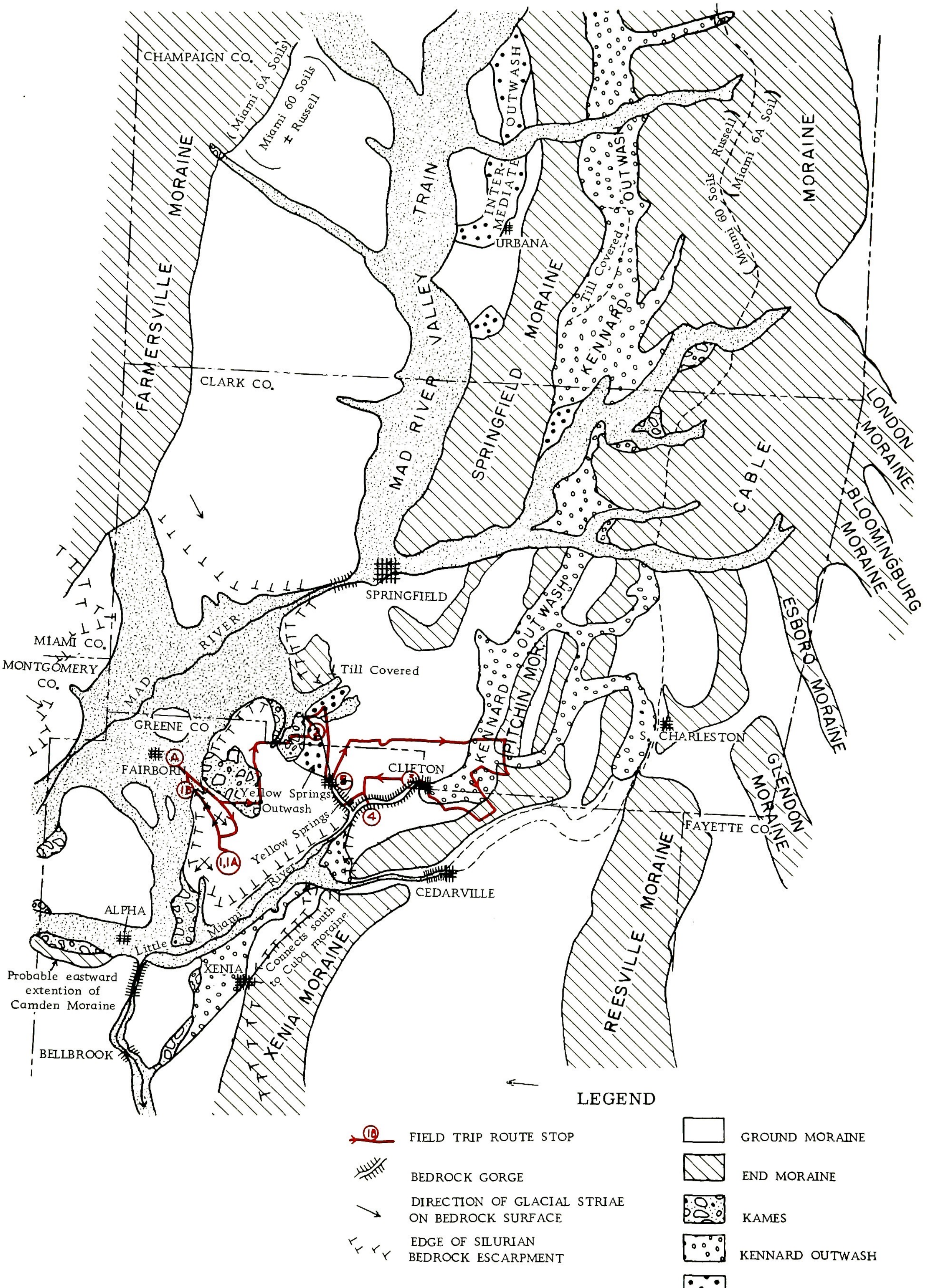
The region should not really be called "interlobate", because the two ice lobes, to the east and to the west, did not reach their maximum position in this area at the same time. The detailed history of this entire area, was worked out by Dr. R. P. Goldthwait for reports published by the Ohio Department of Natural Resources, Division of Water (Clark County, 1952; Greene County 1950; see especially plates 10, 11, and 13, after pages 16, 17, and 18 in the latter); all the information presented here is drawn from either these reports or from him personally.

Moraines marking the receeding margin of the Miami ice lobe are the Pitchin, the Springfield, a series of isolated spots of end moraine and kame moraine west, northwest, and north of Yellow Springs (probably equivalent to the Springfield moraine to the north and the Camden moraine to the southwest), and the Farmersville moraine. Also associated with this Miami ice lobe advance are a well-developed set of striations, oriented to the southeast, which are exposed on the bedrock surface in the quarries of the Southwestern Portland Cement Company near Fairborn.

The major end moraines of the Scioto ice lobe in this area are the Reesville and Xenia moraines, but a sequence of other, younger moraines are present to the east (the Glendon, Esboro, Bloomingburg, and London moraines) which all unite to the north, together with the Reesville, to form the Cable moraine. The Xenia moraine seems to line up with the Scioto lobe Cuba moraine to the south. However, the Pitchin moraine to the north also seems to line up with the Xenia moraine and it can be shown, by pebble counts, that the Pitchin moraine derived from the Miami lobe. (Pebble counts give the number, or percentage, of each major lithology represented in a hundred one-to-three-inch pebbles, Miami lobe counts have been shown to be distinctly higher in dolomite in this area.) Because so many problems were encountered in trying to understand the relationships involved, separate names were assigned to these moraines by Dr. Goldthwait.

Actually, it was Dr. Goldthwait's conclusion (1950) that ice from both lobes covered much of this Yellow Springs area, but at different times. Evidence for this view came partly from the overall relationships of the various deposits, geographic and

FIG. 1 DIAGRAMMATIC MAP SHOWING RELATIONSHIP OF OUTWASH LEVELS AND BEDROCK GORGES IN THE CLARK AND GREENE COUNTY AREA



AFTER GLACIAL MAP OF OHIO BY GOLDTHWAIT, WHITE, AND FORSTH (TO BE PUBISHED IN 1960) stratigraphic (such as till over gravel, which is common near Xenia), from stone counts, and from the occurrence of criss-crossing glacial striations on some of the rock surfaces exposed in the Southwestern Portland Cement Company quarries. The rock containing these criss-crossing striations has long since been blasted away and a recent search here for similar markings has revealed only the single southeasterly direction made by the Miami lobe ice.

This region is also characterized by a number of striking bedrock gorges, whose presence is probably due to the Silurian bedrock escarpment here (see fig. 1). Each gorge ties with a distinct outwash system whose source was to the north in Champaign and Logan Counties (Goldthwait 1955; Forsyth 1956). The detailed topographic features of the gorges of Yellow Springs Creek at Yellow Springs, Little Miami River at Clifton, and Massie's Creek at Cedarville have been described and illustrated by Carman (1946), who has shown how the longitudinal and lateral profiles of the Clifton gorge faithfully reflect variations in the lithology of the local strata. He recognized that the Little Miami River was an important meltwater outlet during Wisconsin time, and considered the gorge to be the result of post-glacial retreat of a waterfall from an original west-facing escarpment of Silurian rocks to the present position just below Clifton. "It is probable that the Little Miami River took its present course across the escarpment with the disappearance of the last ice sheet, the Wisconsin, usually estimated at about 30,000 years ago. During this time the falls has retreated a distance of approximately four miles at an average rate of about nine inches per year" We now know, from abundant radiocarbon dates, that the last glacier left this area about 16,000 years ago, which just about doubles this computed rate.

The highest terrace system, called the Kennard outwash, is also the most easterly. It can be traced south from its source in southern Logan County to the gorge at Clifton (Stops 3, 4, and 4-a). At one stage it also appears to have occupied a more eastern route in southeastern Clark County, so as to feed into the gorge at Cedarville. In order for this to have happened, the more westerly route must have been blocked, presumably by ice. The glacial front must have advanced as far east as the Pitchin moraine at this time. This must have been before the major deposition of the Kennard outwash to the west, because there is no evidence (such as till over the outwash) to suggest readvance of the ice from the west after its deposition. Farther to the north, in both Champaign and Logan Counties, the Kennard outwash is capped by till which was deposited by Miami lobe ice. Actually, the presence of ice was necessary in many areas to form a west wall for the meltwater stream that deposited this outwash, for in these areas, there was no high land to otherwise prevent the water from flowing west into the Mad River valley. In two localities in this more northern area, a red, leached, clay-enriched zone was found beneath this till cap in the top of the gravel. This brings up the sixty-four dollar question: is such a zone a buried paleosol? Does that mean that the Kennard outwash is of "early" Wisconsin age? This has been our (Goldthwait, Forsyth) recent interpretation.

The gorge at Yellow Springs was formed by water which flowed from the northwest, depositing the Yellow Springs outwash just north of town. Because of the water funneling down into the upper end of the gorge, the Yellow Springs outwash has a triangular outline, being narrowest at the lower end next to the entrance to the gorge. At its other, northern end, about two miles north of Yellow Springs, the outwash seems partly to head in an area of kames and partly to end in mid-air above the valley of Mud Run; here again, ice must have been present in order to deposit the kames, to serve as a source for the stream of water and the outwash gravel, and to maintain a continuation of the gradient back upstream. In his mapping along the Mad River valley, Dr. Goldthwait felt that this level was about the same as some intermediate levels of terrace in Champaign County. Their exact correlation is probable impossible, however, because there are actually several such levels to the north and almost no remnants are left in the valley between Champaign County and the Enon-Yellow Springs area. The gravel pit east of Enon (mileage 20.4) exposes some gravel which is probably the same as the Yellow Springs outwash. It is capped by several feet of calcareous till. When this pit was visited on the 1956 Ohio Academy of Science field trip, a red, clay-enriched, leached zone was observed in many places in the top of the gravel, just below the till cap. Was this a paleosol? Is this buried gravel "early" Wisconsin? Is the Yellow Springs outwash the same as this gravel and therefore is it also "early" Wisconsin in age?

The fourth gorge is at Springfield (west of town, just south of the old people's home). This was cut by the same water which deposited the Mad River valley train (this gravel deposit is properly called a valley train, rather than outwash because it is restricted within true valley walls). This is the deposit which fills most of the Mad River valley north of Springfield and southwest toward Dayton. The great width of this deposit southwest of Springfield appears to be a result of the stream's having cut below the Silurian escarpment there. For a time the ice which deposited the Farmersville moraine (see Fig. 1) apparently extended southeastward across the valley of the Miami River at Dayton, because this valley train can be traced southeast from the Mad River valley at Fairborn to the Little Miami River valley at a small town called Alpha (see Fig. 1).

Tributary Mad River valley train gravel also came toward Alpha from the west. At Alpha, the rivers which deposited the valley train flowed south through a narrow bedrock gorge a few miles south of town and also farther south at Bellbrook. This section of valley, with its two bedrock gorges, was the route found by the river which deposited the valley train when it was blocked by the ice dam at Dayton.

In summary of the gorges, we have the following relationships:

Gorge	Associated Outwash	With buried soil under a till cap somewhere?	Headed where?	Ice stood where? Miami lobe?	Scioto lobe?
Springfield to N. Alpha and Bellbrook to S.	Mad River valley train	No	C. Logan Co.	Farmersville moraine (and across present Mad River-Miami River at Dayton)	E. Cable moraine to N. to S? Esboro by glacial story? Reesville by soils?
Yellow Springs	Yellow Springs to S. an intermediate outwash near Urbana to N?	Yes?	? S. Logan Co. N. Champaign Co.	at Kames next to Yellow Springs outwash - W. Springfield moraine?	? C. Cable moraine?
Clifton	Kennard	Yes	S. Logan Co. N. Champaign Co.	Springfield moraine (Camden moraine to SW?)	C-W Cable moraine to N. E. of Xenia moraine?
Cedarville	a higher Kennard	Yes	S. Logan Co. N. Champaign Co.	Pitchin moraine?	C-W Cable moraine to N. E. of Xenia moraine to S.

Return to cars and follow the leader. Proceed north along company roads.

1.1	6.8	Pass under Dayton-Yellow Springs road.
0.4	7.2	Glacial drift exposed in road cut.
0.5	7.7	Contact of till and Brassfield limestone.
0.1	7.8	Full exposure of Brassfield limestone capped by 18 inches of Dayton limestone and up to 15 feet of till (S.W. part of Sec. 8).
0.5	8.3	Company railroad on right. Pass under Byron Road.

0.5	8.8	Grassy slope on left is a former quarry face, graded, resoiled, and planted.
0.1	8.9	Cross under New Germany-Trebein Road.
0.3	9.2	Stop 1-B. Road cut eastern part of Sec. 14.

6. Richmond Group. (Ordovician, refer to stratigraphic section for general description.) The house at right rests on lower Brassfield limestone. Underneath the lower Brassfield formation is a series of impermeable calcareous siltstones and shales referred to as the Elkhorn formation. Outcrops of this formation mark a spring zone which feeds the numerous small streams in the area.

Beneath the upper, more silty layers is a thin bedded, blue-gray shale with thin interbeds of limestone. The color is in places green and red. The red color is particularly marked in a zone about 11 feet thick which lies 30 feet below the Brassfield contact. This markedly red zone, when penetrated in drilling, produces a blood-red sludge and thus serves as a useful marker. This is known by drillers as "the Big Red of the Medina."

For a more detailed description refer to the following drill log.

DRILL LOG

Footage	Description
(Silurian, Lower Brassfield)	
38-43	Light gray-brown, silty limestone, dark-brown oxidized sandy textured limestone, very porous, wet, solution cavities throughout
(Ordovician, Richmond Group)	
43-45	Yellow brown streaks in light to dark gray, fine sandy shale, sand grains very fine grained
45-53	Dense, friable blue-gray, silty shale, thin bedding, occasional glauconitic material
53-57	Streaks of silty friable blue-green-gray clay shale, interbedded in dense blue-gray silty shale; core broken in 1" to 2" increments (possible bedding planes)
57-67 1/2	As above, but more dense, core recovery in large sections
67 1/2-69	Material becoming dark brown (oxidized), composition remains same (fine grained silty-clay shale), bedding not uniform, near horizontal
69-77	Red-brown clay-shale with streaks of blue-gray silty clay shale, fracturing 72-77
77-79	As above, thin beds of blue-gray silty shale becoming prominent at base
79-80	Material becoming chiefly blue-gray with scattered lenses of dark brown shale throughout

80-81		Blue-gray shale, abundant fossils (brachiopods, bryozoa); fossils are white and occur in layers 1/2 to 2" thick
81-82		Material highly fossiliferous, thin parting planes, crinoid stems common
82-85		Shell fragments common, core consists of white fragments of fossils embedded in blue-gray silty-clay shale
85-87		Blue-gray shale, shell fragments very common. Material becoming shaley limestone, fragments of crinoids and shells common
87-89		Becoming more fossiliferous, shaley limestone and blue-white in color
89-91		As above; near bottom, beds of limy fossils interbedded with blue-gray shale
91-95		As above, styolites common, trilobite fragments common
		Return to cars.
0.7	9.9	1- 1-1/4 miles to right is plant of Universal Atlas Cement Co.
0.2	10.1	Approach a company parking lot. Turn right. Cross railroad to State Route 235. Turn right on 235. Retrace route on 235 for 2 miles.
2.0	12.1	Drive (turn) east on Herr Road. Note hummocky topography of kames to either side of road. Hill ahead to right has small abandoned gravel pit in it. Depth of leaching in gravel at first house on left directly beside road was measured at 35". Mapping of the glacial features in both of these counties (Clark and Greene) was by Dr. Goldthwait (published in reports by the Ohio Department of Natural Resources, Division of Water, in 1950 and 1952). It is his data which is presented here.
1.0	13.1	Note black soil in drainage ditch along left side of road. In many areas of central and western Ohio, black soils are the only remaining indication of once-existent prairie vegetation which invaded Ohio about 5,000 years ago during the "climatic optimum" or time when the climate was somewhat warmer and dryer than today. Prairie vegetation, mainly grasses, creates such black soils. Black soils also develop in poorly-drained topographic situations under forest vegetation. The best way for someone who is not a soils specialist to recognize the difference is to see whether the black soil persists up onto the better drained locations, something that only the prairie-produced black soil would do. This has not been checked here. It is likely that this low area is also underlain by gravel.
0.2	13.3	The rise ahead is presumably a bedrock escarpment, probably the escarpment of the Cedarville dolomite. Plastered up against it, at its foot and on its top, are kames. Note the small abandoned gravel pit in the kame to the right.

0.3	13.6	STOP. Turn left (north) off of Herr Road onto West Enon Road. We have just left the area of kames and are now in an area mapped "thin ground moraine"; this term is used because the bedrock is not far below the surface; we are still on top of the escarpment noted above.
0.5	14.1	Tall poles ahead to right are part of aircraft control system of Wright-Patterson Air Base. Re-enter eastern margin of kame area. Most of the kames lie to our left (west), on the top and off the edge of the escarpment. For this reason, very little kamic topography can be seen from here. Gravel was visible at a small excavation just beyond the next house on the left when this itinerary was prepared and may still be observable.
0.6	14.7	STOP. Continue straight ahead. The route here passes back onto thin ground moraine. The boundary of the area of low kames conti nues on diagonally to the northwest.
0.6	15.3	Turn right (east) from West Enon Road, onto East Enon Road, which crosses area of thin ground moraine.
0.8	16.1	Black-top ends; continue straight ahead. Road ahead follows the Greene-Clark county line and is still on thin ground moraine.
0.6	16.7	Note exposure of Brassfield limestone in valley of shallow run (Clear Creek) to left. This is why the ground moraine is called "thin".
0.3	17.0	As road rises from valley of second shallow run (tributary to Clear Creek), we enter another kame field; some higher kames are visible ahead to the left.
0.1	17.1	Turn left (north) from Clark County road onto Lower Snyderville Road, which is located in kame field.
0.5	17.6	STOP. Turn right (east) from Lower Snyderville road onto Jackson Road, which passes over some of the highest kames. Note abandoned gravel pits far to left and in high hill to right.
0.9	18.5	Route drops down off kames onto outwash. This outwash, which on this map has been called the Yellow Springs outwash, forms a triangular shaped area representing a deposit by meltwater which was being funneled down south to the Yellow Springs gorge. From here, part of the surface can been seen, narrowing to the south as it approaches the gorge. The general position of the gorge is marked by the towers which can be seen to the south; these are the towers of the Main Building on the Antioch College campus in Yellow Springs. To the north from here, the outwash can be traced into the kames we have just crossed and to the present valley of Mud Run (see Stop 2).
0.4	18.9	Turn left (north) from Jackson Road onto Old Enon Road, which is still on the outwash.
0.2	19.1	<u>STOP 2.</u> Yellow Springs Outwash and associated glacial deposits.

STOP 2. Yellow Springs outwash and associated glacial deposits.

Park on right side of road as far off road and as close together as possible. Stop is on the Yellow Springs outwash. Outwash surface can be seen extending to the south to where the towers of the Main Building on the Antioch campus in Yellow Springs mark the narrow southern end of the outwash and the Yellow Springs gorge. Across the valley the outwash can be seen in direct contact with the kames we have just crossed. Are these deposits the same age? If the outwash is of the same age as the kames, marking the apron of gravel washed out beyond the kames, the ice must have been very close; kames mark ice-contact positions. Outwash deposited in ice-contact positions, however, is usually marked by kettles, but none have been reported from here. To the northwest (ahead to the left), the outwash ends abruptly in mid-air; where is the upper end of this deposit there? Was the presence of ice necessary to provide the continuation of the gradient? To the northeast (ahead to the right) across the valley of a small creek, a small area of flat land seems to be at the same elevation as this outwash. Gravel is also present there; it may be the same gravel deposit. However, it has a cap of till, meaning that the glacier readvanced over that outwash after gravel deposition ceased, covering it with a layer of till. In a gravel pit in that area (Keiffer Gravel Pit), a red, leached, clay-enriched zone occurs in places in the top of the gravel. What does this mean about the age of that gravel? of the Yellow Springs outwash? of the kames? of the Yellow Springs gorge?

We are not clear about the true relationships of all the deposits in this area, but we will present the best interpretation we have at this stop.

0.3	19.4	Notice houses ahead across valley of unnamed tributary to Mud Run. This is the level of gravel capped by till which was discussed at Stop 2. The route ahead takes us up onto this level. Notice that, ahead after a turn left and right, our road goes into the dissected part of the outwash and approaches the position the ice edge must have had.
0.5	19.9	STOP. Turn right (east) off Old Enon Road onto hard surfaced Fairfield Pike.
0.1	20.0	Note good exposure of Euphemia and Springfield dolomites in bluffs of creek back to left.
0.3	20.3	Note Euphemia dolomite exposed in bottom of creek to right.
0.1	20.4	Gravel pit to left. More pits are present ahead on the left and on the right. The pit on the right (Keiffer Gravel Pit) is the one we visited as Stop 1 on the 1956 Ohio Academy of Science Field trip. The thick, well-bedded gravel which is exposed here and which may be observed best after we turn right ahead, is capped by 3 to 9 feet of till. In the top of the gravel directly underneath the till is a discontinuous zone of red, clay-enriched, leached material; is this the remains of a buried paleosol? Where such zones occur elsewhere in Ohio, overlain by a number of feet of calcareous till, they have been interpreted as buried, truncated paleosols developed in "early" Wisconsin gravels. Does this mean that this gravel is "early" Wisconsin in age? also the Yellow Springs outwash?
0.4	20.8	Turn right off Fairfield Pike to right (south) around gravel pit. After turn, there is a nice view of the working face of the pit showing the bedding in the gravel and the till cap (the upper working level). We will follow this road to the edge

of Yellow Springs.

0.4	21.2	Descend onto lower level of outwash. This gravel is not thick for Cedarville dolomite is exposed in the bottom of the creek (notice especially to the left-(east). Road leaves outwash just beyond house on left and climbs up onto thin ground moraine.
0.9	22.1	View to right (west) to Yellow Springs outwash and to kames we crossed a little while ago. Road is still located on thin ground moraine.
		Cross county line from Clark to Greene County.
0.6	22.7	Another view ahead to the right (west) to the outwash, which is now much more narrow. Back to the northwest the wider outwash and the kame field are still visible.
		This is the site of the old Yellow Springs water works. They used to get their water here, from trenches cut in the outwash. As the town grew, this became inadequate and they drilled wells into the bedrock in town. Eventually, even this supply was insufficient, so they now have wells in the valley of the Little Miami to the south of town and of the gorges. Here they get their water from the thick glacial gravels which fill this valley (information supplied by Mr. Ralph Bernhagen, Chief of the Ohio Division of Geological Survey).
0.4	23.1	Road goes down northeast bank of outwash channel onto outwash. Digging operations to right (which was active during preparation of field guide) exposes gravel. Note how deposit is much more narrow than it was to the north and how it narrows still more ahead to the left, as it approaches the upper end of Yellow Springs gorge.
0.3	23.4	Rise up onto southwest bank of outwash channel.
0.3	23.7	Sign saying "Yellow Springs". Turn left (east) off Polecat Road (North Walnut Street) onto Fairfield Pike.
		Here road drops down at railroad underpass, into outwash channel, now only about 200 feet wide. Bedrock gorge in Cedarville dolomite begins only a few hundred feet to our right (south).
0.4	24.1	STOP. Turn left (north) WITH CARE from Fairfield Pike onto heavily travelled U. S. Route 68.
1.1	25.2	Cross line from Greene to Clark County.
		Route here lies on thin ground moraine, but thick ground moraine is mapped beginning just ahead.
0.6	25.8	Turn right (east) off of U. S. Route 68 onto Jackson Road opposite Lutheran Church.
		Road is on ground moraine that is called "thick". Even so, the unusual flatness is probably controlled by the flatness of the bedrock surface beneath the till.
1.4	27.2	Road jogs right because of the Springfield Municipal Airport visible to left (north).
0.3	27.5	Turn back left (east) again.

1.5	29.0	STOP. Continue straight ahead on Jackson Road across Ohio route 72 over thick ground moraine.
1.2	30.2	Descend onto Kennard outwash. Note the flatness typical of outwash. The hills ahead represent the edge of the Pitchin end moraine. The kennard outwash forms a north-south belt from its head in southern Logan County to the bedrock gorge at Clifton. No single river follows this valley and many streams actually cut across it. In many places, there is no valley wall to the west, so no stream could follow this route without the presence of ice to the west to hold the water in. At one locality in each of Logan and Champaign counties, this gravel has a till cap beneath which, in the gravel, is a red, clay-enriched, leached zone. Is this outwash "early" Wisconsin in age?
1.1	31.3	Turn right (east), staying on hard-surfaced Jackson Road and crossing stream North Fork of the Little Miami River.
		On the east side of the river, road leaves Kennard outwash and rises up onto the Pitchin moraine.
0.2	31.5	Turn right (south) off Jackson Road onto Pitchin Road.
		Road follows crest of Pitchin moraine for 1 1/2 miles and affords views out west (right) onto the Kennard outwash. Note typical hummocky end moraine topography on the Pitchin moraine.
1.2	32.7	Black top ends. Continue straight ahead (south) on Pitchin Road.
		Road descends off Pitchin moraine, crosses outwash-filled tributary to Kennard valley and ascends north end of Xenia moraine. Separate names were used for these moraines in mapping by R. P. Goldthwait, because pebble counts and deductions from the inferred glacial history both suggest that they were deposited at different times by different ice lobes (Pitchin by the Miami lobe, Xenia by the Scioto lobe).
0.9	33.6	STOP. Turn right (west) from Pitchin Road onto South River Road.
		In a third of a mile, we again descend back onto the Kennard outwash.
1.0	34.6	Note gravel exposure with soil on right.
		Turn left (southeast) from South River Road onto Rife Road.
0.3	34.9	Rise up off Kennard outwash onto Xenia moraine.
		About 0.4 miles ahead, the morainic topography becomes particularly strong.
1.3	36.2	Hill to right (south) has abandoned pit in it; this probably represents the location of a kame within the end moraine, a common and expectable feature.
0.2	36.4	STOP. Turn right (south) from Rife Road onto Courtsville Road.
0.6	37.0	STOP. Turn right (west) from Courtsville Road onto Fishworm Road.

Ahead to left is the town of Cedarville with another gorge cut in the Cedarville dolomite. If the valley just above the Cedarville gorge is followed back to the northeast and north, it ties in with outwash in southern Clark county which is co-extensive with the Kennard outwash. The Miami lobe ice had to have advanced east of the area of Kennard outwash for meltwater and glacial gravels to have moved along this route. Because the Kennard outwash has no till cap in these counties, it and its associated gorge (Clifton) are presumed to have been formed later than the Cedarville gravel and gorge.

1.3	38.3	Descend to ground moraine, mapped "thin" at the foot of the end moraine and "thick" nearer the outwash.
0.7	39.0	STOP. Turn right (north) off of Fishworm Road onto Ohio Route 72.
0.3	39.3	Descend onto Kennard outwash which here is narrower than farther north. It narrows still more to left as it funnels into Clifton Gorge, ahead.
0.6	39.9	Enter town of Clifton and cross bridge. Note Cedarville dolomite exposed to either side of the bridge, forming the head of Clifton gorge. This road is the Main Street of Clifton.
0.2	40.1	Turn left (west) onto North Street, which is Ohio Route 343, just south of Sinclair gas station.
0.3	40.4	Road leaves last of Kennard outwash. From here on, all the water went through the gorge, just as Yellow Springs gorge did for the Yellow Springs outwash.
0.1	40.5	Pass over small tributary of Little Miami River, which also flows in a narrow bedrock gorge. Note also abundance of cedar trees here. This is characteristic where dolomite is exposed or close to the surface and has been used as an aid in mapping glacial deposits; abundant cedars <u>suggest</u>, but do not <u>prove</u> the shallowness of the dolomite bedrock. To be used as such an indicator, the cedars must be abundant (not planted) and healthy. Cedars also grow freely on eroded, soil-eroded slopes in areas of calcareous materials and locally where the glacial till is particularly rich in carbonate rock fragments.
0.1	40.6	Turn left into "Bear Cage" parking area and park.

<u>Stop 3.</u> <u>Clifton Gorge.</u> Most of our time will be spent on foot in this section of the gorge. <u>Carelessness can lead to injury here. Please be careful.</u>

The gorges (valleys of Yellow Springs Creek, Birch Creek, Clifton Gorge, and Cedarville Gorge) represent courses occupied and eroded by glacial melt waters.

Large potholes occur in the gorges which do not seem to be related to present stream action. Some, near present stream level, are very large; others are above present stream level. The potholes occur only in Cedarville dolomite, although a few extend down into the Springfield. The average size of potholes in this region, from a total of 59 measured potholes, is 8 feet wide by 6 feet deep (measured by George Stoertz, former Antioch student).

Other evidence of the origin of the gorges will be seen at Stop 5 (Yellow Springs).

Turn left out of parking area and continue west on Ohio Route 343, immediately rising up onto the upland on "thin ground moraine".

0.9 41.5 Note good views of "thin ground moraine" surface, especially to north.

0.9 42.4 Turn left (south) off of Ohio Route 343 (Clifton-Yellow Springs Road) onto Meridith road (State Route 370).

1.1 43.5 Road forks; bear left (southeast) into John Bryan State Park.

Most of the park was once owned by John Bryan who willed the land to the State. The park was landscaped and planted by the Division of Forestry and is now operated by the Division of Parks.

0.3 43.8 Road forks. Take right (south) road and descend into valley of Little Miami River.

Outcrops in the roadcut are the Cedarville, Springfield, and Euphemia dolomites.

0.4 44.2 Park in parking area, for lunch and Stop 4.

Lunch in cars or in park area.

STOP 4. Bryan State Park at Lower Parking Area.

The parking area is part of a large terrace formed at the top of the Silurian Brassfield limestone. Walk across terrace toward the Little Miami River and follow the trail down the steep scarp of the Brassfield limestone.

The Brassfield limestone has been cut by stream action into a prominent cliff in which may be seen three lithologic divisions of the Brassfield: lower 6 feet-thin, regular beds middle 10 feet-massive upper portion-thin, lens like beds, crinoidal.

At the base of the cliff, forming the stream base at this point, is a small exposure of Elkhorn (Ordovician) shale. Walk up stream following guide, crossing bridge over Little Miami River and following trail upstream to exposure in small steep gulley.

STOP 4a. Silurian Section. A limited time will be allowed for observation of the section at this stop.

Here is one of the best exposures in this region of the Silurian section from the Brassfield limestone to Cedarville dolomite. The various units present are:

Formation	Thickness	Description
Cedarville dolomite	up to 50'	gray, massive, pitted; cliff-former
Springfield dolomite	10'	gray, thin-bedded
Euphemia dolomite	7-15'	gray, massive, porous
Massie shale	6'	blue-gray, calcareous, soft
Laurel dolomite	5-7'	buff, hard
Osgood shale	25'	blue-gray, weathering light brown, calcareous
Dayton limestone	5-8'	white, hard, dolomitic
Brassfield limestone	up to 50'	white to pink or red, crinoidal near top, porous dolomitic near bottom; cliff-former

The limestones vary greatly in silica and magnesia content, as shown in the accompanying table:

Silica and Magnesia Content of Limestones*

Formation	SiO_2 (wt.%)	MgO (wt.%)
Cedarville	0.06	21.42
Springfield	4.14	20.41
Euphemia	0.95	21.16
Laurel	5.45	17.50
Dayton	5.90	15.38
Brassfield	1.18	4.35

*analyses after Stout (1942) Dolomites and Limestones of Western Ohio, Bull. 42, Geol. Survey of Ohio.

Some features which may be noted in this exposure are:

1. The sharp contact of the Brassfield and Dayton limestones.
2. The regular bedding of the Dayton limestone.
3. The blue-gray Osgood shale with limestone beds. Fossils are rare. Occasional, well-preserved cephalopods or gastropods can be found. Some beds are marked by worm-like trails.
4. Clumps of pyrite, or where oxidized, limonite in places in the Laurel dolomite.
5. Massie shale usually marked by a spring zone and conspicuous by its lack of resistance to erosion, compared to the overlying dolomites. Notice the "cave" it forms at the head of gulley. Occasional cup corals, brachiopods, trilobites, and crinoid stem plates may be found in the Massie shale.
6. The spectacular cliff at head of gulley formed by the Euphemia, Springfield and Cedarville dolomites. Notice the brick-like structure of the Springfield dolomite and the solution pits in the Cedarville dolomite. Abundant molds of Pentamerus laevis occur in thin horizon near the base of the Cedarville.

Note importance of structure in controlling the topography.

Although the regional dip is very gentle toward the east, smaller structures are present. A small anticline plunging northeasterly lies between Yellow Springs and this area.

Jointing, is quite regular in the Cedarville and Springfield dolomites, with six sets of joints. The joints are approximately vertical and consistent throughout the Yellow Springs region. The directions of the most prominent sets are about N 20° E. and N. 60° E.

Return to cars for departure to last stop.

Follow lead car and proceed to park entrance.

0.7	44.9	Turn left (south) on Ohio Route 370, which leads into Bryan Road.
0.2	45.1	C.C.C. camp on left was used when John Bryan Park was developed.
0.2	45.3	Passing through part of Yellow Springs School Forest (100 acres).
0.1	45.4	Horace Mann statue is in clearing on left. Horace Mann, well known early educator, was the first president of Antioch College. Today this monument is central to a group of

outdoor education and recreation properties totaling 1800 acres.

0.4	45.8	Turn right (northwest) onto Grinnel Road. On the left is the old Grinnel Mill.
		We are now again in the valley of the Little Miami River, which is here floored by Ordovician Elkhorn shale.
		The edge of a buried glacial valley is a few hundred yards to the south. Wells supplying Yellow Springs with water are located here.
0.2	46.0	Cross bridge over Yellow Springs Creek which joins the Little Miami a short distance to the south.
0.2	46.2	Outcrop of Brassfield limestone on left side of road.
0.3	46.5	Intersection of Hyde Road on left; continue straight on (north).
		The steep clif below the road is made of Brassfield limestone. Cedarville and Springfield dolomites crop out adjacent to road.
0.2	46.7	Cross Railroad.
		Turn right (north) on Corry Street, Yellow Springs.
0.5	47.2	Park cars at Trailside Museum on right, or find parking place nearby.

STOP 5. Gorges of Yellow Springs and Birch Creeks. Here, particular attention will be given to further features bearing on the origin of the gorges.

Follow guide down into the "Glen". Refer to Map showing route and numbered features. We will only note in passing, those bedrock features previously seen on the trip.

1. Cedarville Dolomite. The highest outcrops which form bold vertical cliffs bordering the Glen, are Cedarville dolomite.

2. Springfield Dolomite. Underlying the Cedarville dolomite, and forming a marked reentrant profile, is the Springfield dolomite. Note the thin bedding and close jointing which allows the Springfield to by "quarried" by natural processes. Notice large fall-block at turn of trail.

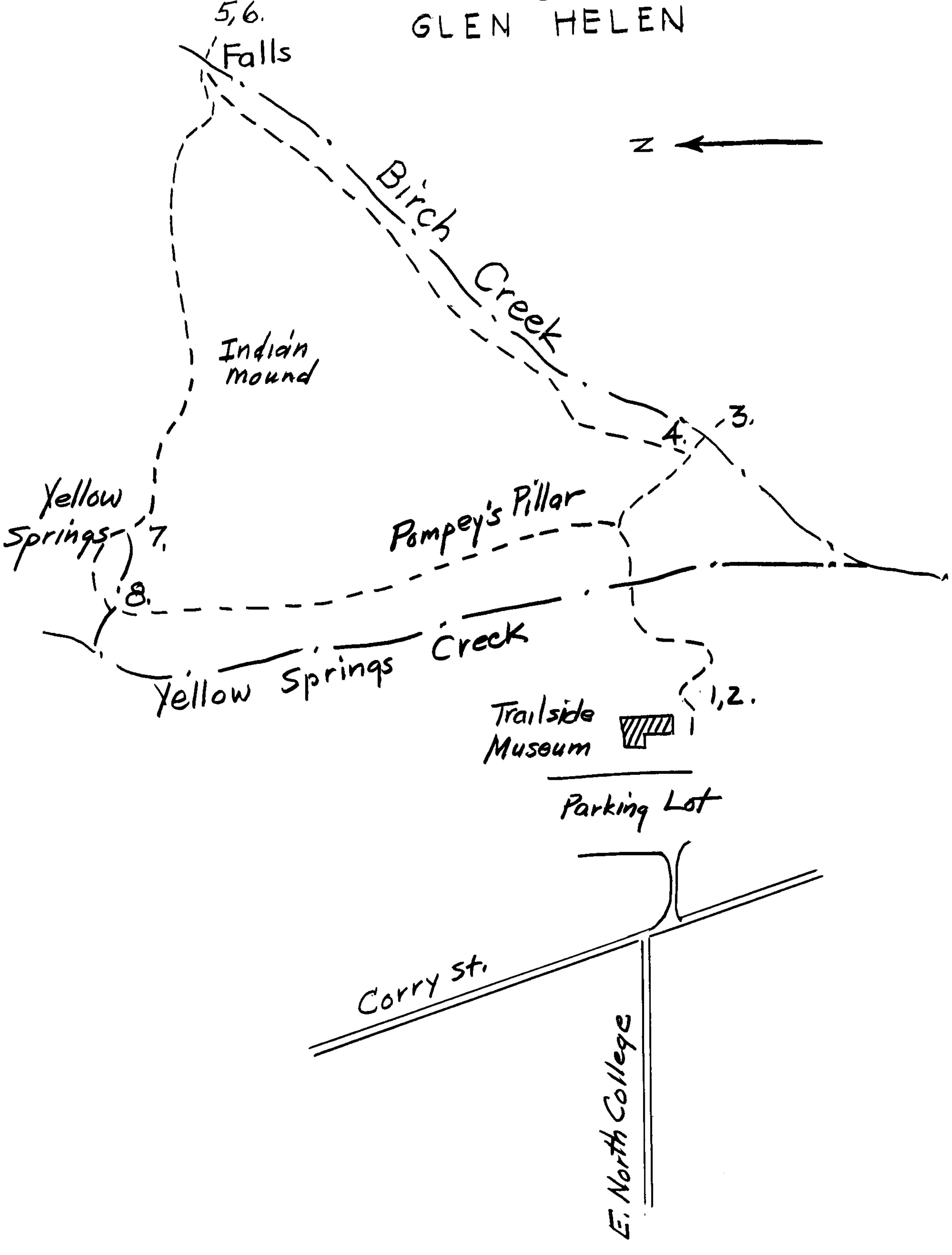
Continue down steps and across Yellow Springs Creek. Note valley width and present stream action.

Turn south following path to a point just above the junction of Yellow Springs and Birch Creeks.

3. Valley of Birch Creek. Note the width of the valley. Birch creek has abandoned channels to the east in prehistoric times. Consider also the large size of bed-load pebbles. Present stream action has exposed these previous deposits.

4. Osgood Shale. An almost complete exposure of the Osgood shale, which

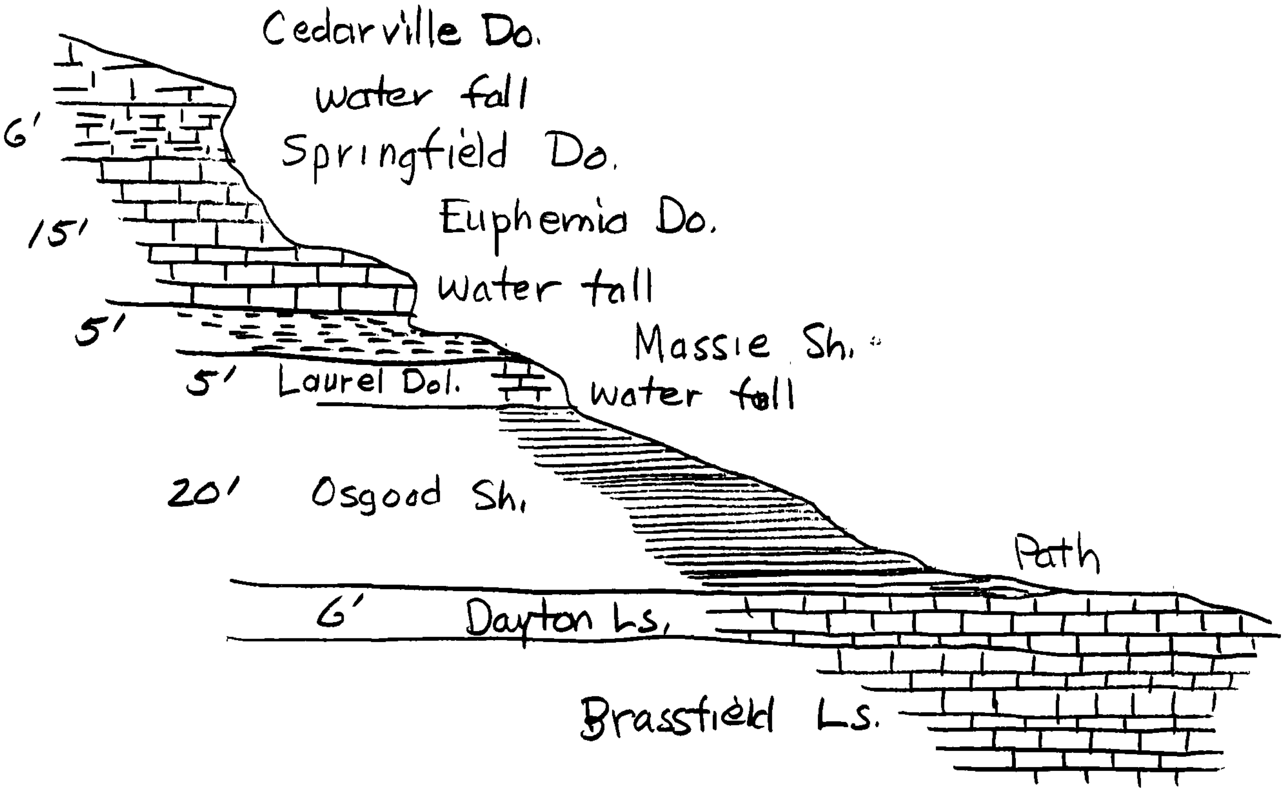
Fig. 2
GLEN HELEN



overlies the Brassfield and Dayton limestones, is present on the northwest bank of the creek. The Dayton limestone underlies the creek and valley alluvium at this point. See the acompanying profile and section.

Fig. 3

Profile – Birch Creek



Proceed upstream along the path on the left side of the creek.

Cliffs of Cedarville dolomite are present on the left and across the valley.

As you continue along path, refer to profile of stream and look for the following:

> overhang of the Cedarville dolomite
> underlying Springfield dolomite
> more resistant Euphemia dolomite
> Massie shale, base of spring zone

Note the structural control of the geomorphic features.

Continue to bridge over Birch Creek.

5. Falls. The lip of the falls is the lower foot of Cedarville dolomite.

6. Potholes. Both upstream and downstream from the falls, pothole-like forms appear in the Cedarville dolomite along the stream sides. The potholes, which are not being formed under present conditions, are attributed to torrential quantities of melt water accompanied by the availability of cobble or boulder tools. Their distribution seems to indicate the present falls have advanced headward less than 100 feet during postglacial time. Follow the path northwesterly leading past the memorial to Helen Birch (plaque on glacial erratic), thence past the Indian mound on the left to the Yellow Springs.

The Indian mound contained a male skeleton with a broad band of mica pressed over the forehead. The nearest source of this type of mica is the Appalachians and typifies the extent of trade carried on by the Mound builders.

Note glacial erratic off right side of trail and nearly opposite the Indian mound. This marks the southeast corner of a former resort hotel, the Neff House (1892), built to exploit the Yellow Springs.

7. Yellow Springs. This is the largest and best known spring in Greene County. At one time the spring furnished Antioch College with its water supply. Earlier the flow was collected in a large pool covering the top of the mound. This enabled patrons of the Neff House to bathe in the "healing" mineral waters.

The spring, which issues from the Cedarville dolomite, has a rate of flow of about 68-80 gpm. Because of the large flow and mineralized character of the water, a large mound of limonite-colored travertine has been built up. Chemical analysis of the water is as follows: *

SiO_2	24. ppm	Na, K	6.9
Fe	1.4	HCO_3	406.
Ca	89.	SO_4	16.
Mg	37.	Cl	2.5
		NO_3	.1

Follow along path to the base of the travertine mound.

*Norris, Cross, and Goldthwait (1950). The Water Resources of Greene County, Ohio, Bull. 19, State of Ohio, Department of Natural Resources.

8. Travertine Mound. Professor A. C. Swinnerton made careful studies of mound dimensions and rate of deposition. The mound, which is 75 feet high and 500 feet in basal diameter, consists chiefly of an earthy, porous tufa strongly colored by a small amount of limonite. About 85% of the material is $CaCO_3$, 6% is $FE_2 O_3$, and the remainder is chiefly organic material. The deposit was laid down in sheet-like layers by the spreading flow of the spring water. Fossil leaves, twigs, and land snails are common.

It is assumed that the deposit has been built up since retreat of the last ice sheet. Apparently the valley was almost its present size when the build-up of the mound began. Calculations based on present depositional rates give an age of 40,000 years, which is too high. Radiocarbon dates give about 14,000 years ago for the time when the last glacier retreated out of Ohio. (about 16,000? for this locality, which is so far south in Ohio).

The dam on the right is the last of several which have been built and washed out. In the days of the Neff resort, this was a popular place for boating. Erosional processes provided sediment which has now filled the pond.

Follow the trail southward, downstream, along the east bank of Yellow Springs Creek. Well up the slope on the left, is an unusual rock column called "Pompey's Pillar" The pillar has moved away from the cliffs by creeping down the slope.

Cross Yellow Spring Creek at bridge, follow path up steps, and return to Trailside Museum.

****

That is all. Return to cars. Have a safe trip home. For route 68 north, turn right on Corry Street and intersect 68 at signal. Turn right for north. For Route 68 south, turn right on Corry Street and then immediately left on North College to stop sign and intersection with 68. Turn left for 68 south.

For Dayton-Yellow Springs Road, turn right on Corry. Continue through first signal (if green) and turn left at second signal.

Drive fast and dangerously, and we will not see you next year.

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